Chapter-5
Climate change in Ethiopia

5.1.Introduction:

Ethiopia is located at 3^0 and 14.8^0N, 33^0 and 48^0E. The climate of Ethiopia is mainly controlled by the seasonal migration of the Intertropical Convergence Zone (ITCZ) (Fig.1) and associated atmospheric circulations as well as by the complex topography of the country.

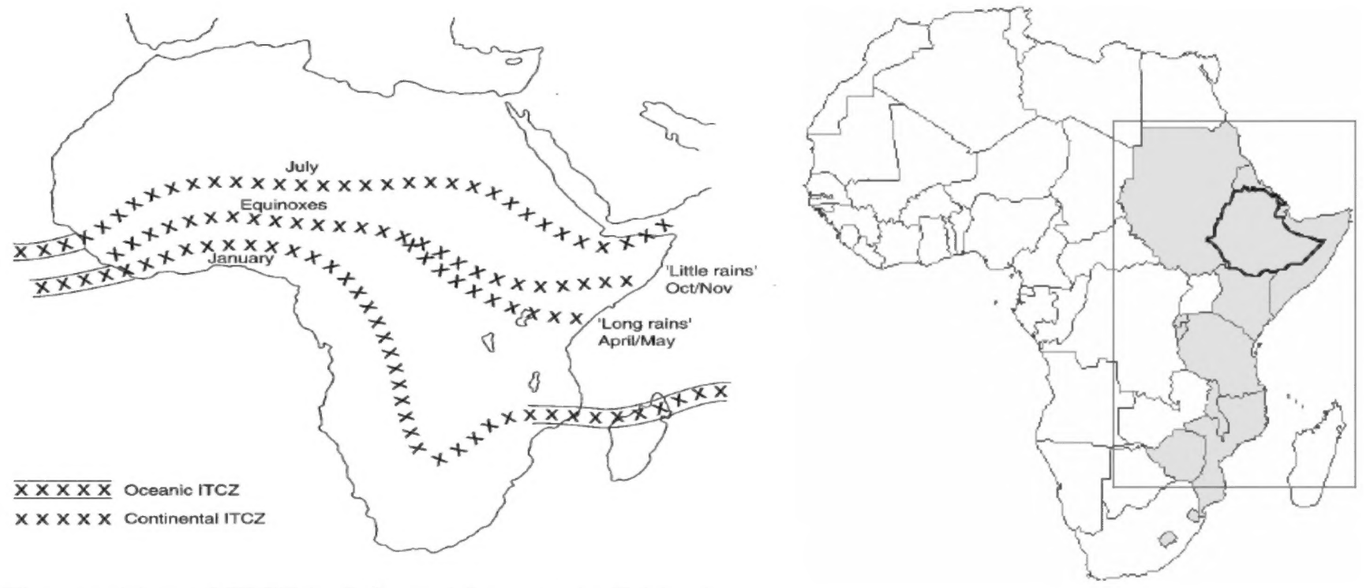

Fig.1 The position of ITCZ in July and January in Ethiopia.

It has a diversified climate ranging from semi-arid desert type in the lowlands to humid and warm (temperate) type in the southwest. Mean annual rainfall distribution has maxima (>2000 mm) over the Southwestern highlands and minima (<300 mm) over the Southeastern & Northeastern lowlands. Mean annual temperature ranges from < 15^0 C over the highlands to > 25^0 C in the lowlands. In terms of rainfall occurrence one can generally identify three seasons in Ethiopia namely; Bega: dry season (October- January), Belg: short rainy season (February- May) and Kiremt: long rainy season (June- September).

The traditional climate classification of the country based on altitude and temperature shows the presence of five climatic zones (Fig.2) namely: *wurch* (cold climate at more than 3000 Mts. altitude), *Dega* (temperate like climate – in highlands with 2500-3000 Mts.), *woina dega* (warm- 1500-2500), *Kola* (hot and arid type, less than 1500m in altitude), and *Berha* (hot and hyper-arid type) climates. Classification with respect to rainfall regimes shows the presence of monomial, bi-modal and diffused pattern of rainfall climates. Consideration of the moisture index shows that large portion of the country falls under semi-arid and arid climates.

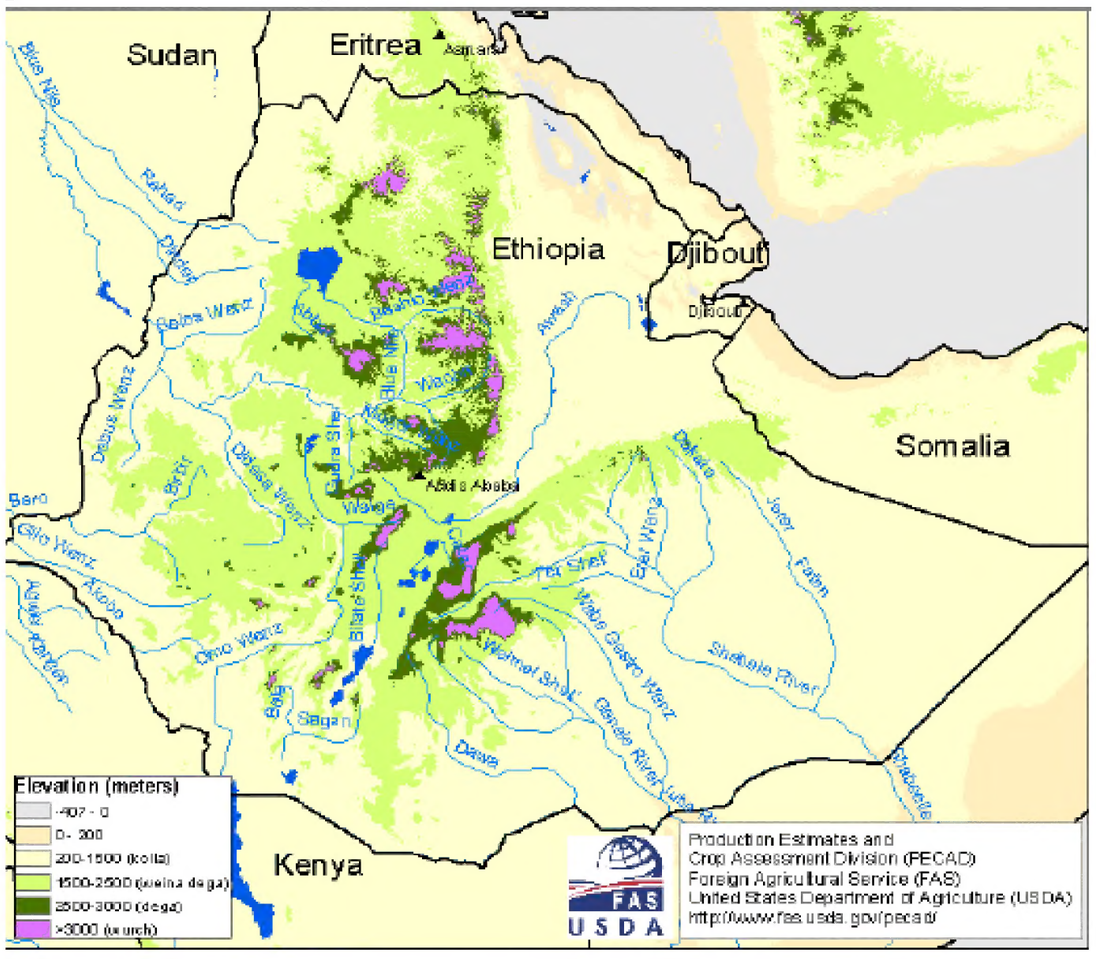

Fig.2. Climatic classification of Ethiopia

- *Wurch (Cold highlands):* Areas above 3000 meters and annual rainfall is above 2200-mm. Barley is the dominant crop and light frost often forms at night.
- *Dega (Cool, humid, highlands):* Areas from 2500-3000 meters where annual rainfall ranges from 1200 to 2200-mm. Barley and wheat are the dominant crops.
- *Weina Dega (Temperate, cool sub-humid, highlands):* Areas between 1500 to 2500 meters, where annual rainfall ranges from 800-1200-mm. This is where most of the population lives and all regional types of crops are grown, especially *teff.*
- *Kolla (Warm, semi-arid lowlands):* Areas below 1500 meters with annual rainfall ranges from 200-800 mm. Sorghum and corn are grown, with teff grown in the better areas.
- The *kolla* is warm all the year round and temperatures range from 27 to 50 degrees Celsius.
- *Bereha (Hot and hyper-arid):* General term that refers to the extreme form of *kolla,* where annual rainfall is less than 200-mm. The *bereha* has desert type of vegetation where pastoralism is the main economic activity. This area encompasses the *Denakil* Depression, the Eritrean lowlands, the eastern Ogaden, the deep tropical valleys of the Blue Nile and Tekeze rivers, and the peripheral areas along the Sudanese and Kenyan borders.

The high dependence of the economy on agriculture means that it is very sensitive to climate variability and this could be an important factor to the vulnerability of Ethiopia to climate change. Major environmental problems in Ethiopia include, soil erosion, deforestation, drought, over-grazing, desertification, loss of biodiversity including wildlife and pollution of water.

Ethiopia is expected to be one of the countries hardest hit by climate change, putting much of its 76.5 million residents at risk. In fact, some climate researchers said Ethiopia was one of the first victims of climate change and already experienced its effect more than 20 years ago.

A global dimming event due to accumulation of aerosols in the atmosphere (Fig.3) during 1980s was probably behind the catastrophic droughts of 1984-85, which led to a famine, killing more than a million Ethiopians. More frequent droughts in recent years have strained the Ethiopian economy, more than 80 percent of which is based on agriculture. In 2007, world health officials estimated that at least 1.5 million Ethiopians were at risk of starvation in the aftermath of a particularly dry year. Deforestation, soil erosion, overgrazing, and desertification have also put pressure on the ecosystem at large, with the loss of several native plant species, and some native bird species on the brink of failure. Climate change is hurting the lifestyle of 20 million nomads who live across the Horn of Africa.

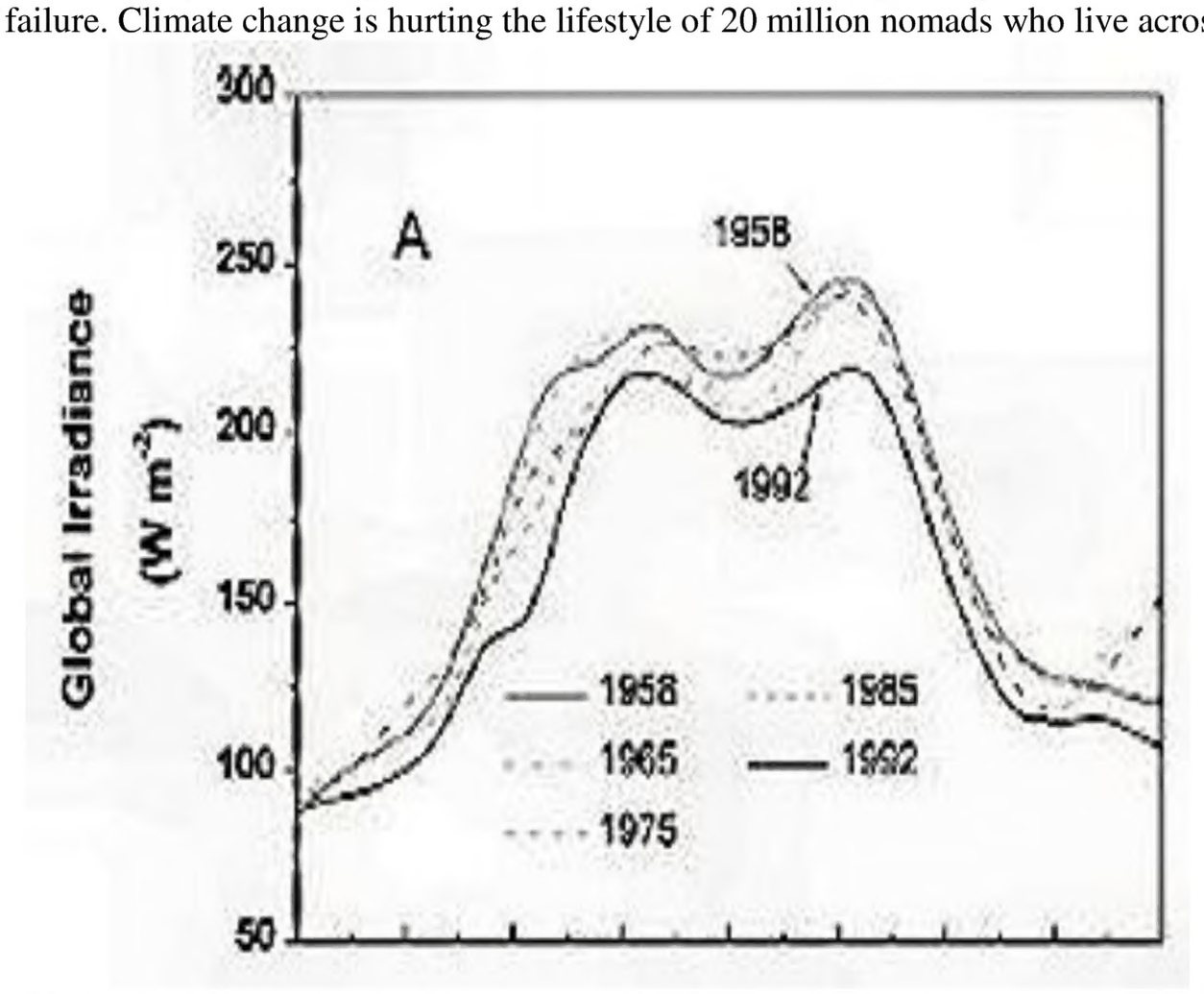

Fig.3. The increase in aerosols decrease the downward reflection that causes the dimming.

In recent years, intertribal fights, over dwindling water resources and vanishing grasslands have been on the increase. In 2006, several tribal leaders gathered in Ethiopia for peace talks, but conflict may continue if the resources grow scarcer.

Total carbon emissions in 1998 were 1,990,000 metric tons, a 33 percent decrease from 1990 levels, and well below the regional averages. An estimated 79 percent of emissions come from liquid fuels, and 21 percent from cement manufacture. The Ethiopian government is signatory to a number of international treaties, including biodiversity pacts, desertification reduction, and protection of endangered species and the ozone layer. It has also signed the Kyoto

Protocol. The government has shown commitment to educate the public and support the development of sustainable practices and green technologies.

A large portion of the country falls under semi-arid and arid climates. Mean annual rainfall ranges from about 2000mm over some pockets in Southwest to less than 250 mm over the Afar low lands in the northeast and Ogaden in the southeast. Rainfall decreases northwards and eastwards from the high rainfall pocket in the southwest. Rainfall during the year occurs in different seasons. Fig.4a. shows different regions that experience different seasons as per rainfall. Unlike most of the tropics where seasons are monomodal (one wet season), there are three seasons in Ethiopia. They are Bega (October to January), a dry season, Belg (Feb-May), a short rainy season, and Kiremt (June – September), a long rainy season.

Fig. 2.1 - The Rainfall Regimes of Ethiopia

Fig.4a. The rainfall regimes of Ethiopia

Temperatures are also very much modified by the varied altitude of the country. Mean annual temperature varies from about 10^0C over the high table lands over Northwest, Central and Southeast to about 35^0C over Northeastern edges. Daily maximum temperature varies from more than 37^0C over the low lands of the Northeast (Afar Traingle) and Southeast (Ogaden) to about 15^0C over the highlands of central and northern Ethiopia. Generally speaking the months of March through May are the hottest during the year. Lowest annual minimum temperatures occur over the highlands, particularly between November and January. Generally, minimum temperatures that reach frost point during the Bega season are not uncommon over the high lands. Also temperatures lower than 5^0C occur during high rainfall months (July and August) over the plateaus in Northwest, Central and Southeast due to high cloud cover. Based on the concept of growing period, the country is classified into three major agro-climatic zones, namely, areas without significant growing period, areas with a single growing period, areas with a double growing period.

In Fig.4b, the four panels on the left and center present the average March-September rainfall for four regions (the northeast, southeast, southwest and northwest). The three panels on the right show the national average precipitation for the March-September, *Belg* (March- May), and *Kiremt* (June-September) time-periods. Running seven-year means have been added to each plot. Orange lines indicate negative rainfall tendencies that may increase food insecurity.

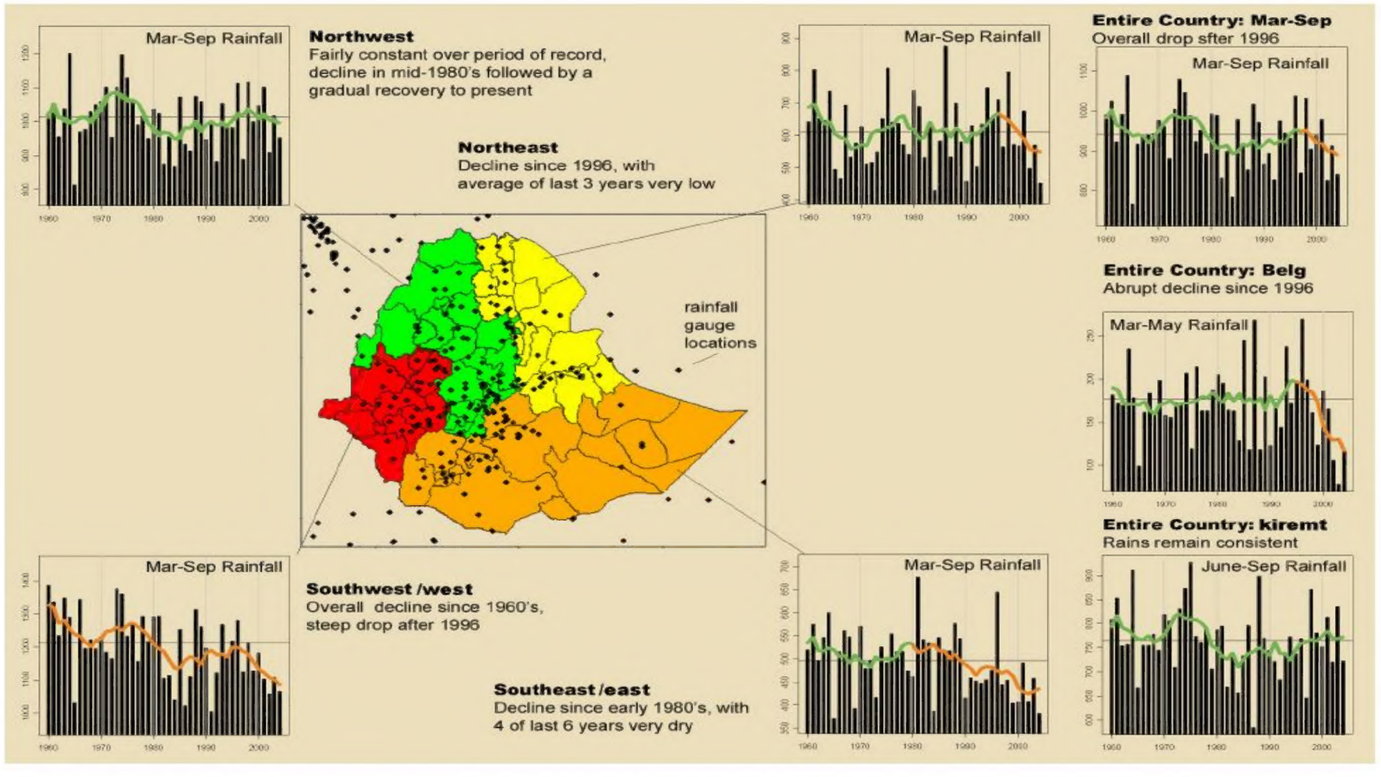

Fig.4b. Rain fall in different regions of Ethiopia

5.2. Research and Systematic Observation

Climate, atmospheric & hydrological monitoring and databases

The responsibility to monitor climate in Ethiopia lies with the National Meteorological Services Agency (NMSA). Currently a network of about 629 (125 principal + 185 ordinary +319 raingauge) meteorological/ climatological stations is managed by NMSA nationwide. NMSA also maintains an upper air sounding station and primary data receiving systems from METEOSAT and NOAA satellites at Addis Ababa. Currently there are no greenhouse gas and ozone monitoring stations in the country.

Climate Change may have far reaching implications to Ethiopia for various reasons. Its economy mainly depends on agriculture, which is very sensitive to climate variations. A large part of the country is arid and semiarid and is highly prone to desertification and drought. It has also a fragile highland ecosystem, which is currently under stress due to population pressure. Forest, water and biodiversity resources of the country are also climate sensitive. Vector-born diseases, such as malaria also affect Ethiopia, which are closely associated with climate variations. Climate change is therefore a case for concern.

The country experiences environmental cum climate related problems such as recurring droughts, a high rate of deforestation, soil degradation and loss, over grazing, etc., which may be exacerbated by climate change.

Five socio- economic sectors namely Agriculture (crops + livestock), Forestry, Water Resources, Wild Life and Human Health have been considered for vulnerability and adaptation assessment.

NMSA uses four categories to compare the seasonal rainfall amount with the long-term mean (SRA stands for Seasonal Rainfall Amount, LYM for Long-Range Mean):

- *Above Normal*: if [SRA/LYM] × 100 > 125%
- *Normal*: if [SRA/LYM] × 100 = 125% - 75%
- *Below Normal*: if [SRA/LYM] × 100 = 75% - 50%
- *Much Below Normal*: if [SRA/LYM] × 100 < 50%

Rainfall trend:

The trend analysis of annul rainfall (Fig.5) shows that rainfall remained more or less constant when averaged over the whole country while a declining trend has been observed over the Northern half of the country (Fig.6) and Southwestern Ethiopia (Fig.8). On the other hand an increasing trend in annual rainfall has been observed in central Ethiopia (Figure7).

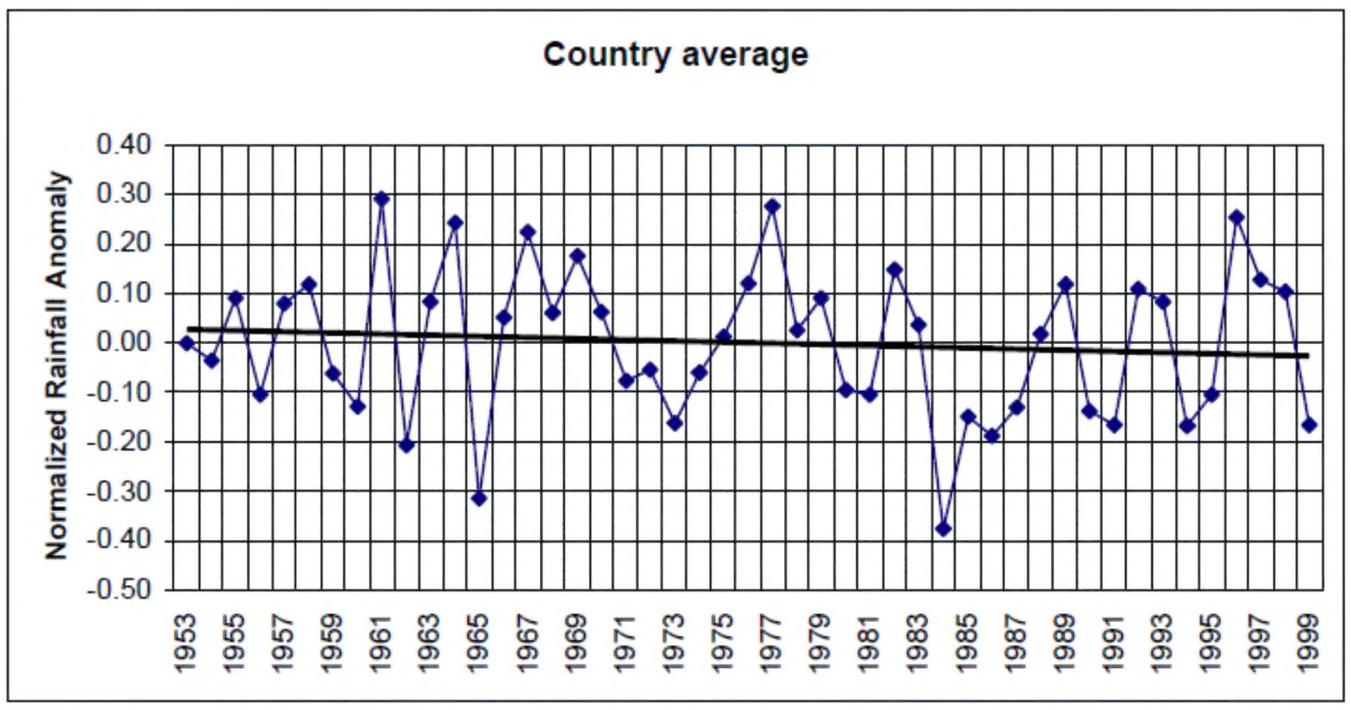

Figure 5 Year to Year Variability of Annual Rainfall over Ethiopia expressed in Normalized Deviation.

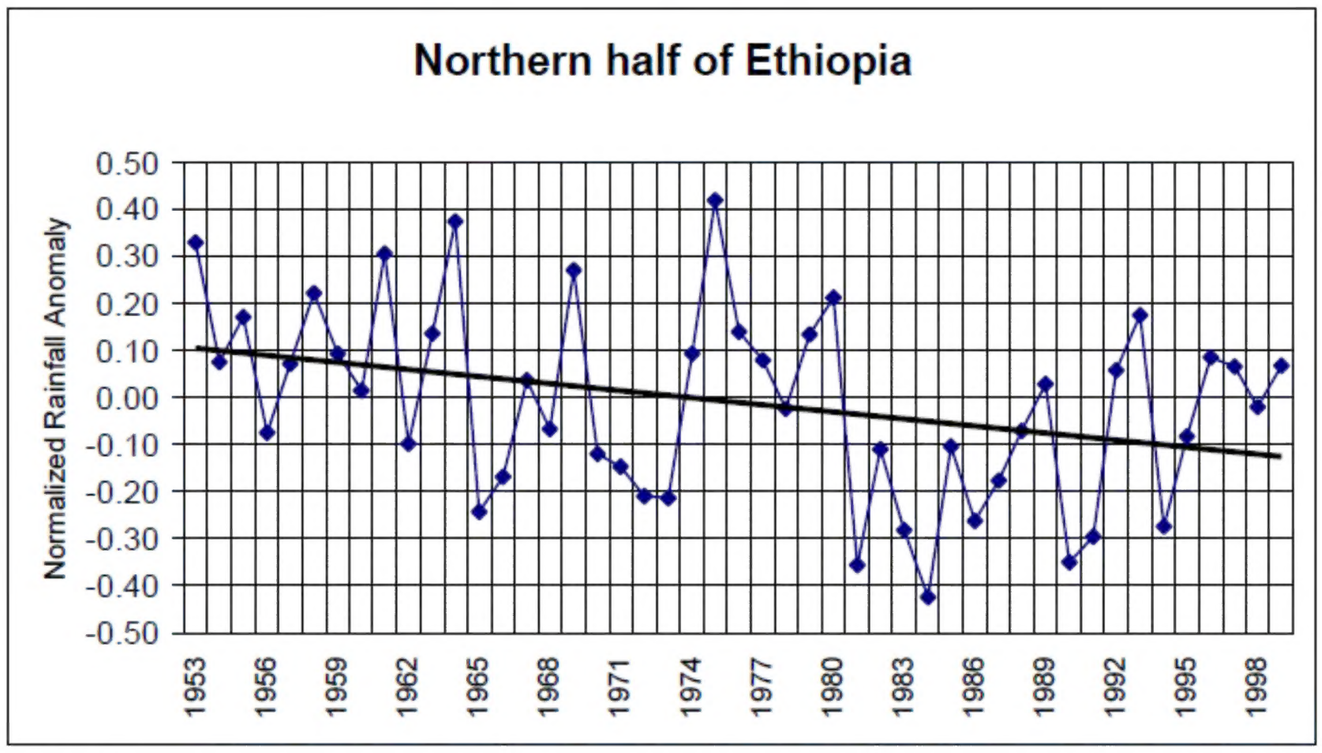

Figure 6: Year to Year Variability of Annual Rainfall over Northern half Ethiopia expressed in Normalized Deviation.

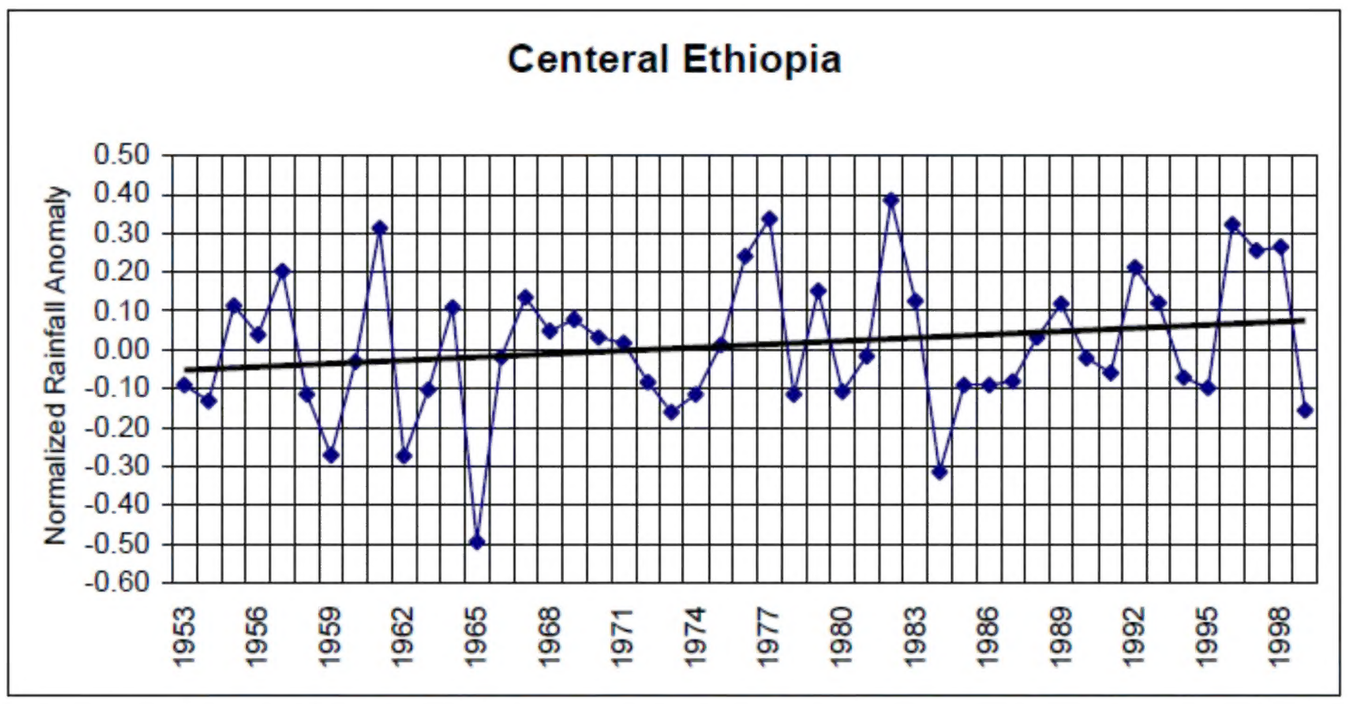

Figure 7: Year to Year Variability of Annual Rainfall over Central Ethiopia expressed in Normalized Deviation.

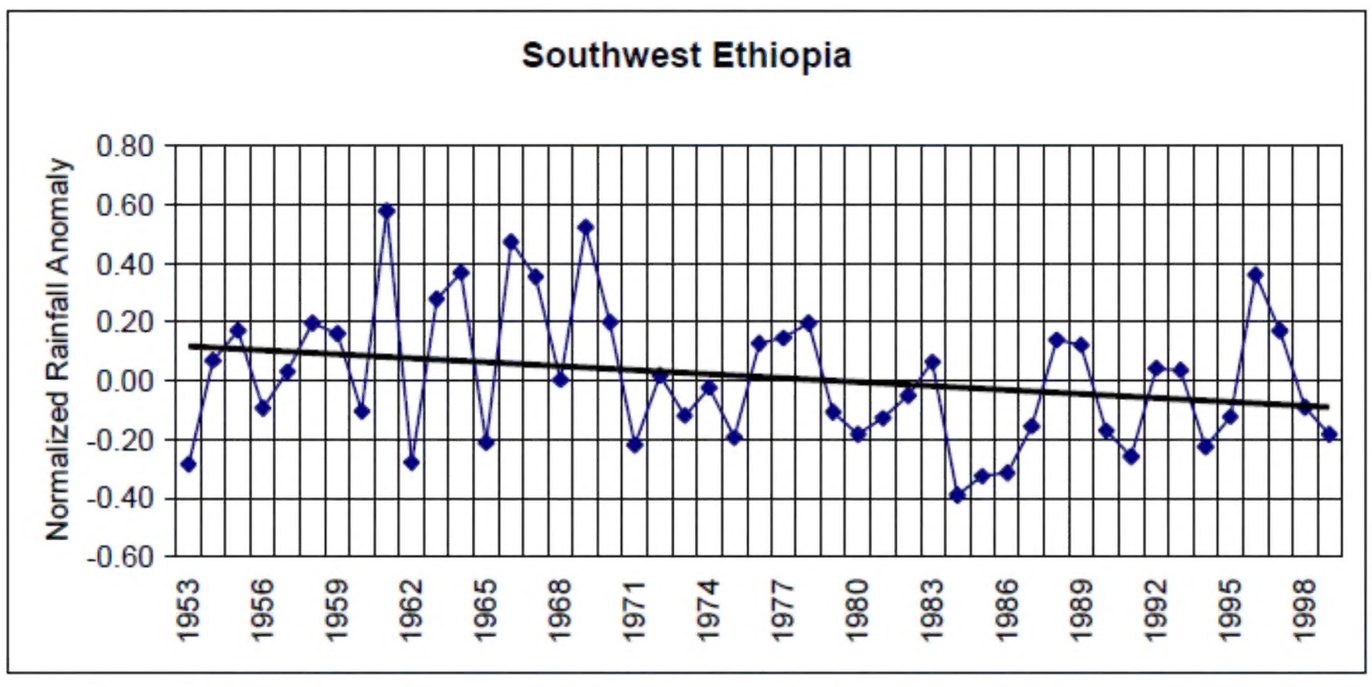

Figure 8: Year to Year Variability of Annual Rainfall over Southwestern Ethiopia expressed in Normalized Deviation.

Climate variability refers to time-scales ranging from months to decades. Climate is extremely variable particularly over the arid and semi-arid parts of Ethiopia. The annual rainfall variation is mostly associated with variation in sea surface temperature (SST) over the tropical Pacific. Warm SST (El Nino) leads to reduction in the summer rains, while the cold phase (La Nina) has the opposite effect. Figure 9 shows an example for Combolcha station in north-eastern

Ethiopia, a region frequented by droughts. The major droughts of the 1970s, 1980s, and 1990s demonstrate the extreme climate fluctuations over this part of the country.

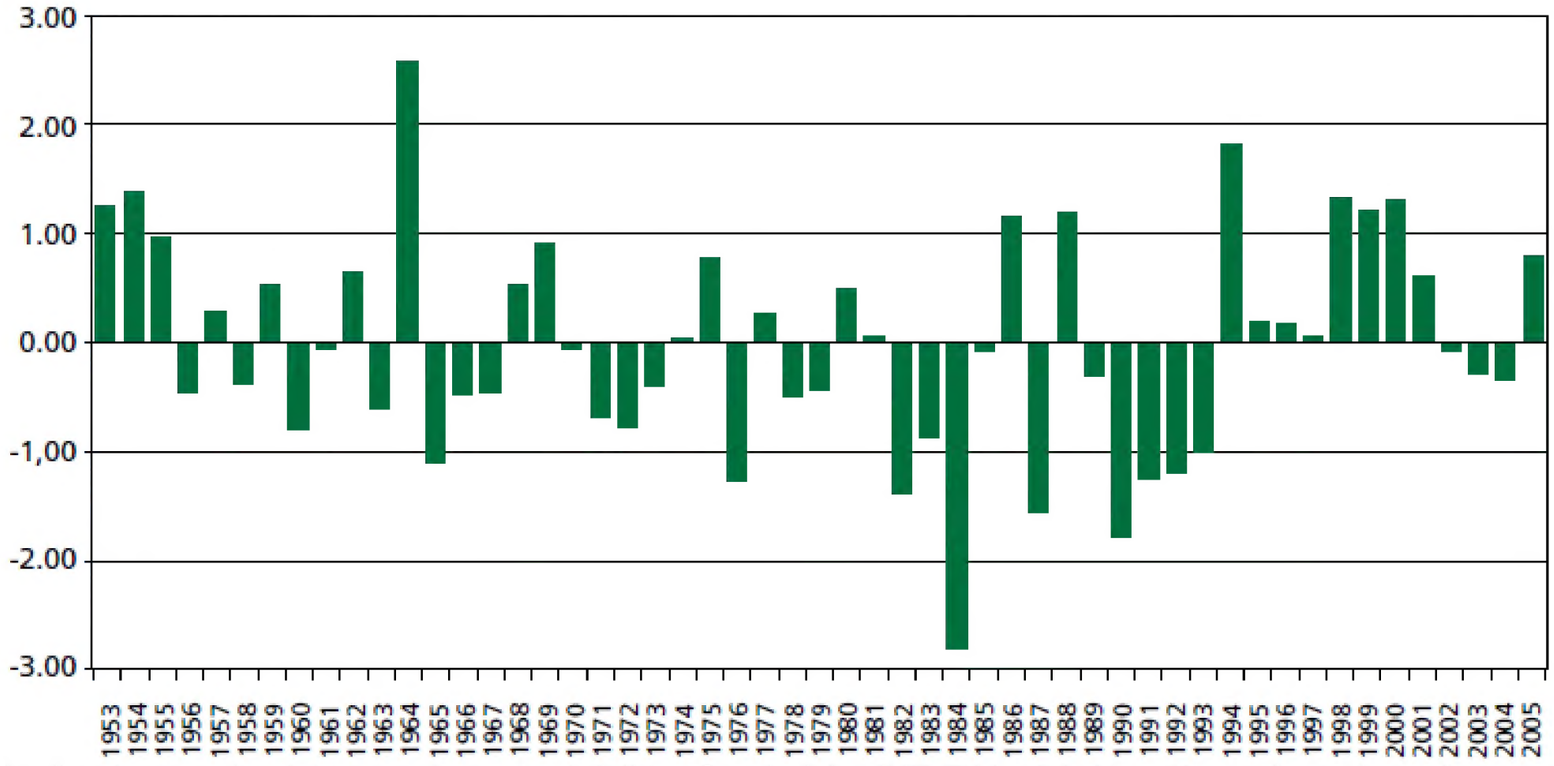

Fig. 9 Standardized anomaly of June to August rainfall for Combolcha (NE Ethiopia). Negative values show dry years while positive values represent wet years.

5.3. Ethiopia's Contribution to Climate Change

The per capita GHG emissions in 1994 come to 900 kg CO_2 equivalent. Compared to other countries, Ethiopia's emissions are very low (e.g. the U.S. emissions amount to 23.7 tonnes CO_2 equivalent per capita in 1994).

Sectorwise, Ethiopia's GHG emissions are dominated by agriculture, which contributes 80% of the total GHG emissions. This reflects the fact that livestock farming goes together with high methane emissions. The dominant position of livestock farming in Ethiopia's economy also influences the relative contribution of GHG to the total emissions (see Figure 10 &11). These are dominated by methane emissions, which account for 80% of the warming potential.

In addition to agriculture, the energy sector (heating, cooking, and transport) contributes to the total GHG emissions with 15%. 95% of the energy consumption is satisfied by bio-mass sources (mainly wood); petroleum and electricity are of minor importance.

Ethiopia's GHG emissions are closely linked to basic needs of the population: Food production (through livestock farming) and heating. Therefore, the future GHG emissions will likely to increase with the projected increase in population.

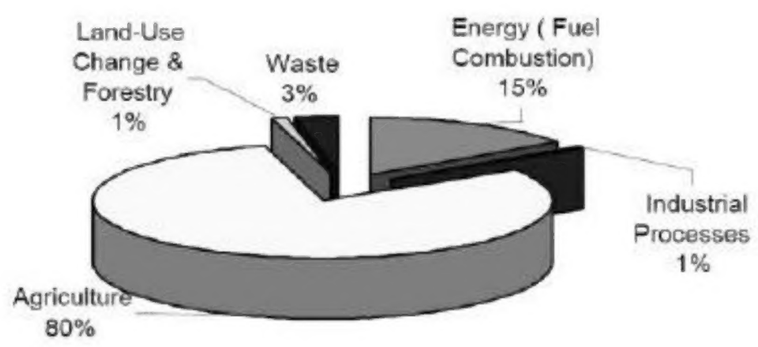

Figure 10: Total greenhouse gas emissions by each sector in 1994 in Ethiopia.

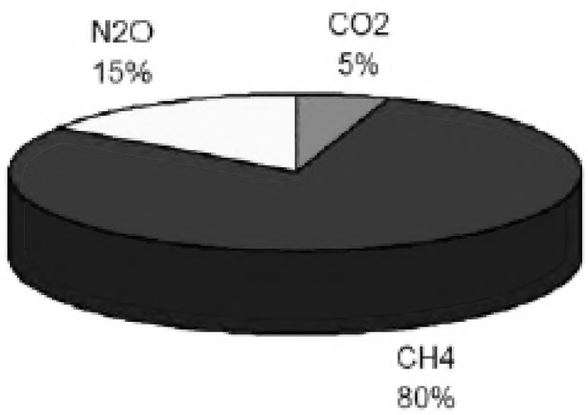

Figure 11: Relative contribution of individual greenhouse gases by Ethiopia

The increasing occurrence of late rains and droughts is consistent with scientific assessments on the impacts of climate change in Ethiopia. Droughts can be associated with higher temperatures and consequential higher evaporation rates. Increased variability of rains is consistent with changes in local rainfall patterns. Predictions of future temperature rise and ever increasing rainfall variability mean that both droughts and late rains will probably become more pronounced in the coming decades.
Malaria is related to climate change, as the presence of mosquitoes is mainly a question of temperatures and humidity. Increased temperatures allow mosquitoes to reach higher altitudes. Earlier, malaria used to occur in the lower parts of the area, now it reaches the mid- to high-lands.
Crop pests can be related to drought conditions. Many worms, such as the army worm proliferate in hot and dry conditions.

Contribution of Green house gas emission by Ethiopia:
Carbon dioxide (CO_2)
About 88% of total CO_2 emission comes from fossil fuel combustion and the Transport (road) sector. The Industrial sector contributes 12% of the total CO_2 emissions mainly as a result of cement production. The country's stock of natural forests, woodlands, shrubs and plantations sequestered majority of it.
Methane (CH_4)
The Agriculture sector (enteric fermentation) is by far the largest source of methane emissions in Ethiopia followed by the Energy sector resulting from fossil fuel use in the residential sub-sector
Nitrous oxide (N_2O)
The Agriculture sector is the principal source of Nitrous Oxide emissions in Ethiopia contributing 81% of the total emission mainly as a result of fertilizer use in agricultural soils. The Energy and Waste sectors contribute 12% and 6% respectively to the total national Nitrous Oxide emissions. The contribution of the Land-Use change & Forestry sector to the N_2O emissions is found to be negligible.

5.4. Greenhouse Gas (GHG) Mitigation Options

There is a general increasing trend of GHG emissions in Ethiopia due to socio-economic development and population growth. On the other hand, the sink capacity of the country in the LUCF (Land-Use change & Forestry) sector is decreasing rapidly due to deforestation mainly for agricultural and energy use. The following mitigation options are taken up:

- Promoting the use of renewable energy such as hydro, solar, wind, biomass and, geothermal energy sources.
- promoting energy efficiency and improved biomass and charcoal stoves, such as 'Mirt Mitad and lackech'.
- Promoting the use of fuels with low carbon content (fuel switching) by exploiting the Ogaden natural gas reserve and use of gasohol (blending of gasoline with ethanol which is a by-product of sugar factories in the country) for various purposes like transport.
- The promotion of the use of smaller cars, improving the efficiency of operating vehicles by carrying out maintenance, promoting environment friendly transport modes such as bicycles.
- Improving forest management practices, protection/preservation of existing forests from losses by deforestation and other practices, initiating new afforestation and reforestation programs, rehabilitation of degraded forests, promoting agro-forestry, developing and restoring gallery forests along river banks.
- Increasing livestock productivity through improved nutrition with supplementation and treatment of forages to improve digestibility and through improved genetic characteristics, promoting sustainable agriculture, promoting mixed crop livestock farming practices where appropriate**,** promoting the use of manure-management system facilities, adopting appropriate fertiliser application, promoting conservation tillage techniques to sequester carbon in cultivated soils, rehabilitation of overgrazed watering points and long-term settlement areas and redistribution of manure that is accumulated near these settlements.
- Integrated waste management & composting of solid waste like that of Addis Ababa city and landfill gas recovery from solid waste.

5.5. CDM (Clean Development Mechanism)

CDM does not improve the energy situation directly but it can be a good incentive to attract private investors now that the CO_2 market is expanding all over the world and the price of CO_2 is increasing. Also, the promotion of renewable energy and the reduction of emissions of greenhouse gases was one of the main commitments of the Japanese Government at TICAD IV and the Tokyo Summit. Therefore, a quick look at the CDM situation in Ethiopia is like this.
As the hydropower, which is the main energy resource in Ethiopia, does not emit CO_2, CER (Certified Emission Reduction) is relatively low compared to the countries where fossil fuel electric power generation is the mainstream power source.
Institutional Arrangements
Ethiopia has signed the Kyoto Protocol and the EPA (Environmental Protection Authority) under the MoME (Ministry of Mine and Energy) was designated as the DNA (Designated National Authority), which is the official agency, dealing

with all CDM projects in the country, to follow up the Kyoto Protocol. DNA only deals with administrative work and the Steering Committee consisting of MoME, MoARD (Ministry of Agriculture and Rural Development) and EEPCo is responsible for the substantial issues. EPA has just prepared a regulation on sustainability and environmental assessment, which will come into force soon.

5.6. Vulnerability Assessment and Adaptation Options:

The degree of the impact will vary across nations. The IPCC findings indicate that developing countries will be more vulnerable to climate change. Preparing for adaptation to the impacts of climate change by carrying out climate change impact assessments is one of the commitments of Parties under the UNFCCC (United Nations Framework Convention on Climate Change).

The 1961-90 period climate has been taken as the baseline climate of the country. Future changes in climate are projected using one-transient and three equilibrium General Circulation Models (GCMs) and incremental scenarios. Socio economic scenarios have also been prepared until the year 2030.

Five socio- economic sectors namely Agriculture (crops + livestock), Forestry, Water Resources, Wildlife and Human Health are considered for vulnerability and adaptation assessment. Models such as DSSAT, WatBal, Holdridge Lifezone and expert judgement are used in the analysis.

5.6.1. Adaptation options for the Crop sector

Potential adaptation measures to cope with adverse impacts of climate change on crop production could be

- Improving and changing management practices and techniques such as planting date, seeding rate, fertilizer application rate, etc;
- Change in crop regions;
- Proper use of climate information for land use planning and early warning systems etc.
- Promoting irrigation agriculture;
- Enhancing erosion control;
- Adopting suitable crop varieties and developing new ones.

5.6.2. Adaptation options for the Grassland and Livestock sector

- Improving the survival and productivity level of the livestock and the rangelands;
- Engagement in obtaining food from other sources and income generating activities in times of crises; and
- Scaling down of family members and migration for survival.

5.6.3. Adaptation options for the highlands:

Selection of crops and cropping systems that maximize biomass production and therefore, CO_2 and N_2 fixation;

- Improved animal genotype and better disease parasite control to take advantage of the improved management; and
- Use of multipurpose cattle that work and provide milk and meat and also breed to provide suitable draught animals, in addition to supplying fuel and fertilizer from their excreta.

5.6.4. Adaptation options for lowlands/rangelands

- Strengthening the early warning systems and coping strategies;
- Introducing mixed farming system, wherever appropriate;
- Destocking of livestock on a regular basis;
- Water resource development in appropriate sites;
- Promote lifestyle choices of pastoralists through access to education and local urban development;
- Rehabilitation of bush encroached areas;
- Conservation and utilization of hay from natural pastures (hay making with local grasses);
- Promotion of herd diversification;
- Promotion of grazing management schemes;
- Use of local legume forage including acacia fruits and leaves;
- Capacity building and institutional strengthening of the local community; and
- Integrated approach to pastoral development.

5.7. Policies, Programs and Measures related to Climate Change

Ethiopia has ratified the United Nations Framework Convention on Climate Change (UNFCCC), the Biodiversity Convention, Desertification Convention, Convention and Protocols to protect the Ozone Layer, etc. Accordingly relevant governmental institutions have been entrusted to discharge responsibilities in the area of environment and development and amongst which, the NMSA is mandated to deal with climate related affairs.

Table 1. Institutional roles and strengths in Ethiopia	
Institution	**Role**
PMO	Provides political decisions and strategic policy directions, in negotiating; leads on the national Environmental Council; plays a largely political and constitutional role.
Environmental Council	Approves environmental standards and directives, recommends laws, establishes the MSC and appoints its chair; composed of the PM plus leading officials from government, the private sector and civil society.
Ministerial Steering Committee	Oversees, monitors implementation and expenditure; chaired by the head of EDRI and composed of state ministers and senior officials from participating institutions; responsible for direction setting and expected outcomes of the CRGE.
EPA	Provides technical supervision and expertise as well as monitoring implementation; composed of leading professionals and an 'expert team'.
MoFED	Secures and channels finance; hosts and administers the CRGE Facility, which allocates resources according to priorities.
Technical Committee	Technical committee chaired by the head of the EPA; composed of STC chairs, and responsible for coherence and approval of content; discusses output from STCs; reviews, prioritises and approves projects and programme funding and coordinates CRGE functions of EUs; composed of chairs of environmental units and experts from EPA and MoFED.
STCs	There are seven Sub-sectoral Technical Committees chaired by senior experts from leading ministries; around 50 experts are involved from 20 government institutions developing sectoral plans that will feed into a federal plan; these are largely responsible for context development.
Regional Environmental Agencies	Coordinate regional implementation and are composed of experts; responsible for coordinating environmental issues including climate change.
Environment (or CRGE) Unit	Develops sectoral implementation plans for the CRGE, funding proposals and coordinates, and drives implementation; composed of selected experts from each involved institution; helps to refine policy and implement the arrangements identified in the vision; responsible for identifying the priorities for climate activities, including identifying research gaps and refining climate action plans, establishing an M&E framework and tracking national progress towards a climate resilient green economy.
Climate Change Unit of MoA	The unit focuses on mainstreaming climate change issues in the different sub-sectors.
Woredas	Some districts have developed local *(woreda)* adaptation plans (e.g. in Oromia and Afar regions) according to interviewee at EPA.
Kebeles	Unclear how much, if any, consultation has taken place below the woreda level with kebele leaders and/or communities.

PMO: Prime Minister's office, EPA: Environmental Protection Authority, MoFED: Ministry of Finance & Economic Development. STC: Sectoral technical committee. CRGE: Climate Resilient Green Economy, MOA: Ministry of Agriculture,

5.8. Modelling & Projections:

5.8.1. The Impacts of Climate Change in Ethiopia

Over the last few decades, the mean temperature of Ethiopia increases by about 0.2° C per decade. The increase of minimum temperature is more pronounced with roughly 0.4° C per decade. The average precipitation, on the other hand, remains fairly stable over the last 50 years. However, the spatial and temporal variability of precipitation is high (see Figure 12).

The future changes in precipitation and temperature as projected by various global climate models are summarized in Figure 12. Most of the global climate models project an increase in precipitation in both the dry and wet seasons. Studies with more detailed regional climate models, however, indicate that the sign of the expected precipitation change is uncertain. The temperature will very likely continue to in-crease for the next few decades with the rate of change as observed.

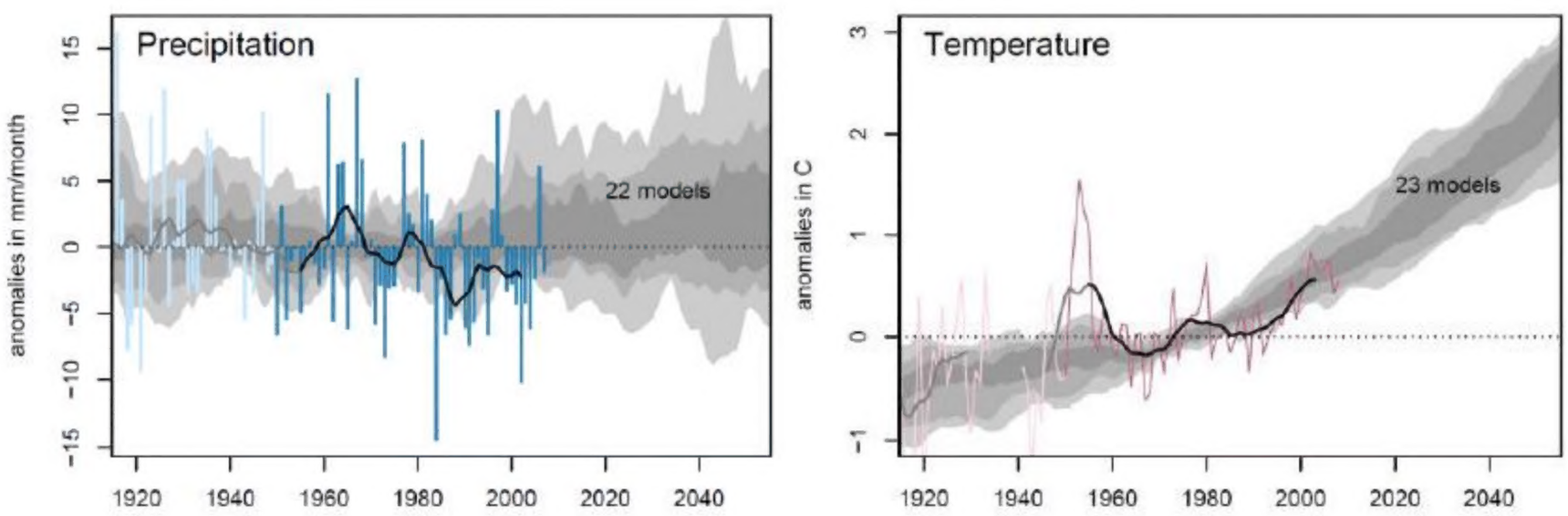

Figure 12: Observed precipitation and temperature changes in Ethiopia (annual averages) along with simulated changes by 22 & 23 global climate models respectively (IPCC, 2007). The observed changes are likely to be flawed by network density changes and measurement errors in the first half of the 20th century (light colours).

The projected increase in the interannual variability of precipitation in combination with the warming is likely to increase in the occurrence of droughts. Further, heavy rains and floods are projected to increase.

Detrimental and beneficial impacts of the ongoing and projected climate change and variability are widespread in both socio-economic and natural systems. These impacts include:

- Agriculture, Food Security: The increasing year-to-year variability and increases in both droughts and heavy precipitation events lowers agricultural production with corresponding negative effects on food security.
- Water: The availability of clean drinking water is likely to decrease due to the increasing evaporation and the increasing variability of rainfall events.

- Health: Incidences of malaria in areas of the highlands where malaria was previously not endemic. The warming is further expected to cause an in-crease in cardio-respiratory and infectious diseases.
- Ecosystems, Biodiversity: Climate change and forest fires threaten the forest ecosystems. A large number of plant and animal species also is threatened by extinction, as climate conditions are changing too quickly to adapt.
- Infrastructure: Heavy rainfall events and floods cause damages to roads and buildings.

The ATA (Agricultural transformation Agency) confronts a reality of increasing ambient temperatures by some 0.3 degrees Celsius per decade since the 1990s (NMA, 2007) causing shifting of boundaries in the agro-ecological zoning of the country. This will intensify further. According to Conway and Schipper (2011) climate change scenarios specific to Ethiopia have projected (Fig.12) mean annual temperature across the country increases by 1.4 to 2.9°C by 2050s. Projections regarding rainfall are less certain, but suggest the possibility of more frequent and intense patterns of extreme weather. At the national level, World Bank suggests that climate change may reduce Ethiopia's GDP compared to a baseline scenario by 2 to 6% by 2015, and by up to 10% by 2045. Referencing the same source, the CRGE (Climate Resilient Green Economy) says that climate change will reduce Ethiopia's GDP growth by 0.5 to 2.5% per year unless effective steps are taken to build resilience. CRGE, launched in 2011, has been described as a 'strategic framework for organising Ethiopia's response on climate change'.

5.9. Current Coping Strategies:

Crop diversification as a reaction for reduced productivity. This strategy is not considered very sustainable or efficient, as it can only help marginally.
- Fallowing, as a reaction for reduced productivity of soils. This is sustainable, but requires sufficient possession of land.
- Using crop residues, Grow and store herbs and straw for animals, as a reaction to the reduced fodder availability. It is sustainable and works mostly.
- Water harvesting (retention and storage measures, terracing) as a reaction to water shortage. This strategy is considered to work well and is sustainable, as it can also increase groundwater levels.
- Well digging as a reaction to water shortage. Women, who mentioned this strategy, said it works and is sustainable. However, women mentioned also that water tables are declining and that well digging is not feasible anymore in all areas.
- Constructing ponds against water shortage. This is sustainable, but not very efficient.
- Planting trees is a measure against soil erosion. This is sustainable and quite efficient.
- Diversification of incomes through livestock, bees and poultry, against reduced incomes. This is sustainable, but not very effective, as theses activities are difficult to put in place.
- Petty trade (grain and other sales), as a reaction to the reduced incomes. This strategy is considered efficient and sustainable.
- Reduction of expenses, as reaction to the reduced incomes. It is not sustainable, except for some social expenses such as funerals. It works partly.
- Reduction of food consumption a general reaction to food insecurity. It works, but it is not sustainable and dangerous.
- Saving and borrowing, as a strategy against famines/droughts, it works temporarily that too if not everyone is affected. It is not sustainable.

- Sale of livestock, as a reaction to the reduced incomes. This is neither sustainable nor efficient, as in times of food insecurity, animal prices are lower.